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For: BRAKE COOLING MECHANISM OF FOUR-WHEELED VEHICLE

VERIFICATION OF ENGLISH TRANSLATION

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Dear Sir:

I, the below named translator, hereby declare that:

My name and post office address are as stated below;

That I am knowledgeable in the English language and in the Japanese language and that I believe that the attached English translation is an accurate translation of Japanese Patent Application No. 2002-248848 filed on August 28, 2002.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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This is to certify that the annexed is a true copy of the following application as filed with this Office.

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Item:	Drawings	1 copy
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[DOCUMENT NAME] Specification

[TITLE OF THE INVENTION]

BRAKE COOLING MECHANISM OF FOUR-WHEELED VEHICLE

[WHAT IS CLAIMED IS]

[Claim 1] A brake cooling mechanism of a four-wheeled vehicle in which a rotation member of a drive power transmission system for rear wheels is provided with a brake device of the vehicle, comprising:

a belt cover having an air discharging hole, in which the belt cover covers an automatic V-belt transmission; and

an air discharging duct connected to the air discharging hole of the belt cover,

wherein the air discharging duct extends up to the brake device or up to a vicinity thereof so as to discharge air toward the brake device.

[Claim 2] The brake cooling mechanism as claimed in claim 1, wherein the air discharging duct has a rising part which is higher than an outlet part of the air discharging duct.

[Claim 3] The brake cooling mechanism as claimed in claim 1 or 2, wherein the brake device is a wet multiple-disk braking device.

[Claim 4] A brake cooling mechanism of a four-wheeled vehicle, wherein a wet multiple-disk braking device is mounted in front of a final reduction gear for rear wheels,

wherein the wet multiple-disk braking device and the final reduction gear are housed inside a single casing, and

wherein the single casing has an oil sump under the wet multiple-disk braking device.

[Claim 5] The brake cooling mechanism as claimed in claim 4, wherein the single casing of the wet multiple-disk braking device has a front surface which tilts with respect to a direction of a width of the four-wheeled vehicle.

[Claim 6] The brake cooling mechanism as claimed in claim 1, wherein a wet multiple-disk braking device is mounted in front of a final reduction gear for the rear wheels,

wherein the wet multiple-disk braking device and the final reduction gear are housed inside a single casing, and

wherein the single casing has an oil sump under the wet multiple-disk braking device.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Field of Application in Industry]

The present invention generally relates to a brake cooling mechanism for a four-wheeled vehicle, and particularly relates to the brake cooling mechanism which is suitable for a straddle type all-terrain four-wheeled drive vehicle with four-wheel independent suspension system.

[0002]

[Prior Art]

As a straddle type all-terrain four-wheeled drive vehicle, there is a Japanese Laid-Open Patent Publication No. 2000-272315. According thereto, a brake casing is integrated with a swing arm device for supporting rear wheels, in which a rear axle case is coupled to a rear end of the swing arm, in which a final reduction gear for rear wheels is housed inside the rear axle case, and in which a wet multiple-disk braking device is housed inside the brake casing.

[0003]

In order to lubricate and cool down the brake device and the final reduction gear for the rear wheels, an oil chamber is provided in a part inside the swing arm device, which is a different part from the brake device, and the lubricant stored in the oil chamber is employed for lubricating and cooling down the brake device and the final reduction gear.

[0004]

On the other hand, Japanese Laid-Open Patent Publication No. 59-130791 discloses a three-wheeled vehicle, as another piece of prior art, in which a wet multiple-disk braking device, composed of a friction plate, a separator plate, etc., is mounted between a brake center fixed to a ring gear of a differential device and an inner surface of a case of the differential device.

[0005]

The friction plate of the braking device, etc. is cooled down, by employing a lubricant stored inside the casing of the differential device.

[0006]

[Problem to Be Solved by the Invention]

In the aforementioned pieces of conventional art, the brake device is cooled down on the basis of the cooling effect by the lubricant which is commonly used in the final reduction gear, and on the basis of the radiation effect (releasing effect) of the friction heat from a surface of the casing by air which is gained while the vehicle is running. In the conventional arts, however, a means or artifice to positively promote the radiation of heat from the surface of the casing, is not provided.

[0007]

According to the former piece of prior art, the oil chamber is mounted separately from a brake chamber and a final reduction gear chamber. Therefore, the path to allow the lubricant to circulate becomes complex, and its smooth circulation of the oil can not be expected so much.

[0008]

On the other hand, according to the latter piece of prior art, inside a casing, accommodating a large bevel gear

(ring gear) having a large outer diameter, of the final reduction gear, there is mounted the brake device having an outer diameter greater than the large outer diameter of the large bevel gear. Therefore, the casing of the final reduction gear becomes large, and the minimum height of the casing relative to the ground level becomes low, thus unsuitable for the straddle type four-wheeled drive vehicle. In addition, in order to increase the amount of the lubricant, it is necessary to downwardly extend a lower part of the casing of the final reduction gear, and thus it is more difficult to secure a predetermined minimum height of the casing relative to the ground level.

[0009]

[Object of the Invention]

Therefore, it is an object of the present invention to effectively take away the frictional heat generated in the brake device, and to effectively radiate the heat from a surface of the casing. It is also an object of the present invention to secure enough minimum height of the body of the vehicle with respect to the ground level, while the function to radiate the heat, as aforementioned, is increased.

[0010]

[Means for Solving the Problem]

In accomplishing the above objects, a brake cooling

mechanism of a four-wheeled vehicle as claimed in claim 1, is the brake cooling mechanism in which a rotation member of a drive power transmission system for rear wheels is provided with a brake device of the vehicle, characterized in that there are provided:

a belt cover having an air discharging hole, in which the belt cover covers an automatic V-belt transmission; and

an air discharging duct connected to the air discharging hole of the belt cover,

wherein the air discharging duct extends up to the brake device or up to a vicinity thereof so as to discharge air toward the brake device.

[0011]

According to the mechanism of claim 1, air for cooling down the brake device is supplied to the brake device by making use of air which is discharged from the automatic V-belt transmission. Therefore, there is no need of providing a fan, or the like, for cooling the brake device exclusively, and it is possible to enhance the performance to cool down the brake device at a low cost.

[0012]

The invention defined in claim 2, is characterized in that the air discharging duct has a rising part which is higher than an outlet part of the air discharging duct, in the brake

cooling mechanism of claim 1.

[0013]

According to the mechanism of claim 2, it is possible to prevent water and/or mud from entering the belt cover through the air discharging duct. Therefore, the mechanism is advantageous to the all-terrain vehicle which runs on a seashore, a waste land, etc.

[0014]

The invention defined in claim 3, is characterized in that the brake device is a wet multiple-disk braking device, in the brake cooling mechanism of claim 1.

[0015]

According to the mechanism of claim 3, the radius of a frictional plate of the brake device can be made small, and enough volume, for lubricant, of an oil sump below can be secured without lowering a bottom surface of a casing.

[0016]

The brake cooling mechanism defined in claim 4, is characterized in that a wet multiple-disk braking device is mounted in front of a final reduction gear for the rear wheels,

wherein the wet multiple-disk braking device and the final reduction gear are housed inside a single casing, and

wherein the single casing has an oil sump under the wet multiple-disk braking device.

[0017]

According to the mechanism of claim 4, since the oil sump is provided in the casing under the wet multiple-disk braking device, it is possible to store a large volume of lubricant therein and to secure enough height of the final reduction gear for the rear wheels with respect to the ground level. Also, the lubricant circulates inside the common casing having a large volume. Therefore, a large heat radiation area (heat releasing area) is secured, the heat releasing effect increases, and the cooling-down effect enhances.

[0018]

Also, the wet multiple-disk braking device is mounted in front of the final reduction gear, and the oil sump is provided in the casing thereunder. Therefore, the casing of the wet multiple-disk braking device gets, or is hit by, air which comes from a front of the vehicle while the vehicle is running. As a result, the function to release the heat is promoted.

[0019]

According to the invention of claim 5, the front surface of the casing of the brake cooling mechanism is characterized by tilting with respect to a direction of the width of the four-wheeled vehicle, in the wet multiple-disk braking device of claim 4.

[0020]

According to the mechanism of claim 5, the air hitting the front surface of the casing of the wet multiple-disk braking device while the vehicle is running, flows readily and smoothly along the front surface of the casing, resulting in increase of effect to release (radiate) the heat.

[0021]

The invention of claim 6 is characterized in that the wet multiple-disk braking device is mounted in front of a final reduction gear for the rear wheels,

wherein the wet multiple-disk braking device and the final reduction gear are housed inside a single casing, and

wherein the single casing has an oil sump under the wet multiple-disk braking device., in the wet multiple-disk braking device of claim 1.

[0022]

[Embodiment]

Figs. 1 through 5, show a straddle type all-terrain four-wheeled drive vehicle to which the present invention applies. With reference to the figures, it is explained below about an embodiment of the present invention.

[0023]

(Layout of Four-wheeled Drive Vehicle)

In Fig. 2 which is a right side view of a whole four-wheeled drive vehicle, a pair of left and right front

wheels 1 are arranged at a front end part of a frame F extending in a direction of front and rear of a body of the vehicle. Each of the left and right front wheels 1 is supported by a suspension mechanism so as to be able to swing up and down, independently. The suspension mechanism has a pair of front suspension arms 3 which have lower and upper arms, respectively, and also has a shock absorber 5. In the figure, only the lower A-shaped arm is shown. A pair of left and right rear wheels 2 are arranged at a rear end part of the frame F. Each of the left and right rear wheels 2 is also supported by a suspension mechanism so as to be able to swing up and down, independently, like the front wheels 1. The suspension mechanism has a pair of rear suspension arms 7 which have lower and upper arms, respectively, and also has a shock absorber 8. In the figure, only the lower A-shaped arm is shown.

[0024]

Between the front wheel 1 and the rear wheel 2, there is arranged a power unit P which has an engine 10, an automatic V-belt transmission 11, a gear transmission 12, and so on. The power unit P is arranged a bit forwards with respect to a center between the front wheel 1 and the rear wheel 2 in the direction of front and rear of the body of the vehicle. On an upper part of the frame F, there are provided a straddle type seat 14, a bar-type steering handle device 15, and so on.

[0025]

Fig. 1 is a plan view showing a drive power transmission system for the four-wheel drive vehicle. There is provided a differential gear 20 for the front wheels 1, centrally in the direction of width of the body of the vehicle, between the left and right front wheels 1. The differential gear 20 has left and right output shafts which extend in the direction of right and left of the body of the vehicle, and each of the output shafts is connected to one end part of each of left and right front wheel drive shafts 23, through a constant velocity universal joint 22. In the arrangement, the other end part of each of the front wheel drive shafts 23 is connected to each of left and right wheel shafts of the front wheels 1, through a constant velocity universal joint 24. The right and left front wheel drive shafts 23 are constructed to have equal length, and they are mounted generally symmetrically with respect to a centerline C of the body of the vehicle. Also, the left and right front suspension arms 3 are constructed to have equal length to each other, and they are mounted generally symmetrically with respect to the centerline C. The differential gear 20 for the front wheels 1 has an input shaft 25 which is mounted in a position that is offset rightward relative to the centerline C, by a distance of "d" (on a horizontal axis O1), in which the input shaft 25 is positioned

in parallel with the centerline C.

[0026]

Between the left and right rear wheels 2, there is provided a final reduction gear 30 for the rear wheels 2, centrally in the direction of width of the body of the vehicle. The final reduction gear 30 has left and right output shafts 31 which extend in the direction of right and left of the vehicle, each of the output shafts 31 is connected to one end part of each of left and right rear wheel drive shafts 33, through a constant velocity universal joint 32, and the other end part of each of the rear wheel drive shafts 33 is connected to each of rear wheel shafts of the rear wheels 2, through a constant velocity universal joint 34. The left and right rear wheel drive shafts 33 are constructed to have equal length to each other, and they are mounted generally symmetrically with respect to the centerline C. Also, the left and right rear suspension arms 7 are constructed to have equal length to each other, and they are mounted generally symmetrically with respect to the centerline C. The final reduction gear 30 for the rear wheels 2 has an input shaft 35. The input shaft 35 is provided with a small bevel gear (pinion gear) 37 which is fixed to a rear part thereof, and the bevel gear 37 locates generally at a central part relative to the direction of the width of the body of the vehicle. The input shaft 35 tilts so

that a front part thereof locates rightwards.

[0027]

(Automatic V-belt Transmission)

There is arranged an automatic V-belt transmission 11 on a right side of the engine 10. The automatic V-belt transmission 11 has a drive pulley 47 which is coupled to a crankshaft, extended sideways, of the engine 1, a driven pulley 48 which is coupled to an input shaft of the gear transmission 12, and a V-belt 49 which extends between the drive pulley 47 and the driven pulley 48. The automatic V-belt transmission 11 operates in such a manner that a reduction ratio thereof changes automatically from a state of maximum reduction ratio upon starting the operation to a state of a low reduction ratio according to an increase of the engine speed, or in such a manner that the reduction ratio increases automatically, as the load from the side of the wheels increases.

[0028]

The automatic V-belt transmission 11 is covered by a belt cover 13 which has an air inlet hole 16 for cooling at its front part, and which has an air outlet hole 17 at its rear part. In the construction, outside air is taken in the air inlet hole 16 by an air sucking fan which is arranged on a rear side of the drive pulley 47, the air cools down the automatic V-belt transmission 11, and the air is discharged from the air outlet

hole 17.

[0029]

(Drive Power Transmission System for Transmitting Drive Power from Power Unit to Differential Gear for Front Wheel and to Final Reduction Gear for Rear Wheel)

A power takeoff shaft 39 of the power P unit is provided in a lower portion of the power unit P so as to extend backward and forward in parallel with the centerline C. The power takeoff shaft 39 is mounted on a right side of the centerline C, and it locates on the axis O1 which corresponds to the axis O1 of the input shaft 25 of the differential gear 20. The power takeoff shaft 39 is interlocked to an output shaft 43 of the gear transmission 12 through small and large bevel gears 41 and 42.

[0030]

A front part of the power takeoff shaft 39 projects forwards from a front edge of the power unit P (i.e. front edge of the engine 10). A rear part of the input shaft 25 of the differential gear for the front wheels 1 and the front part of the power takeoff shaft 39 are connected to each other, with a front propeller shaft 26. The front propeller shaft 26 locates on the axis O1 which is coaxial with each of the input shaft 25 and the power takeoff shaft 39 and which is parallel with the centerline C. In the construction, a connection part

between a front part of the front propeller shaft 26 and the input shaft 25, and a connection part between a rear part of the front propeller shaft 26 and the power takeoff shaft 39, are arranged on the same axis O1 as the axis of the three shafts 25, 26 and 39. Therefore, the connection parts are not composed of universal joints, but are composed of coaxial spline couplings 27, 28 which are simple in constitution.

[0031]

Fig. 3 is an enlarged view of a horizontal cross section showing the power transmission mechanism for driving the rear wheels 2. A rear part of the power takeoff shaft 39 projects rearwards from a rear edge of the power unit P (a rear edge of the gear transmission 12). The rear part of the power takeoff shaft 39 is coupled to the tilted input shaft 35 of the final reduction gear 30, via a tilted rear propeller shaft 36 for the rear wheels 2. The distance between a rear part of the power takeoff shaft 39 and the final reduction gear 30 in the direction of the front and rear of the vehicle is set to be longer than the distance between the front part of the power takeoff shaft 39 and the differential gear 20 (Fig. 1). Particularly, according to the embodiment, the distance between a rear end of the power takeoff shaft 39 and a front end of the input shaft 35 of the final reduction gear 30 is set to be longer than the distance between a front end of the power takeoff shaft 39 and

a rear end of the input shaft 25 of the differential gear 20 (Fig. 1).

[0032]

As aforementioned, the input shaft 35 of the final reduction gear 30 has the small bevel gear 37 which is positioned generally centrally with respect to the width of the body of the vehicle, and the front part of the input shaft 35 tilts on the right hand side towards the front of the vehicle, with respect to the centerline C. The angle θ1 of inclination of the input shaft 35 relative to the centerline C, is set to be 11 degrees, for example. In other words, the input shaft 35 inclines at an angle of 79 degrees (i.e. θ2=79 degrees), with respect to an axis O3 of a hollow shaft 61 for the rear wheels 2 to which the large bevel gear 38 is mounted.

[0033]

The propeller shaft 36 tilts rightwards towards the front of the vehicle at the same angle θ1 as that of the input shaft 35 with respect to the centerline C, and the rear propeller shaft 36 is positioned on the same axis O2 which is the axis of the input shaft 35. The propeller shaft 36 has an intermediate shaft 45 which constitutes a front part of the propeller shaft 36 and has a hollow shaft 46 which constitutes a rear part thereof.

[0034]

A front part of the intermediate shaft 45 is coupled to the rear part of the power takeoff shaft 39, through a constant velocity universal joint 40. The rear part of the intermediate shaft 45 has an outer spherical spline 45a, with which an inner spline formed on a front part of the hollow shaft 46 engages so as to able to move in the direction of the axis of the propeller shaft 36. With the construction, the propeller shaft 36, as a whole, can expand and contract in the direction of the axis O2, and at the same time a slight bending thereof can be absorbed in the spherical spline 45a.

[0035]

A rear end part of the hollow shaft 46 engages with an outer spline of the input shaft 35. Between the intermediate shaft 45 and the hollow shaft 46, there is mounted a compressed coil spring 44, the biasing force of which all the time acts in the direction of keeping both of the shafts 45 and 46 apart from each other. The biasing force exerted on by the coil spring 44 prevents any play in the direction of the axis from occurring inside the propeller shaft 36. Also, thereby, it is possible to detachably mount the propeller shaft 36 without removing the final reduction gear 30 from the frame F.

[0036]

(Final Reduction Gear for Rear Wheel and Brake Device)

As shown in Fig. 3, the final reduction gear 30 for

the rear wheels 2, has the small bevel gear 37 and the large bevel gear 38 which meshes with the small bevel gear 37, and there is arranged a wet multiple-disk braking device 50 for the input shaft 35 which inclines rightwards forwards. A casing for the final reduction gear 30 and a casing for the braking device 50, are formed integrally to each other. The integrally formed casing has a housing 51 which surrounds both of the bevel gears 37 and 38, a right side cover 52 of the housing 51, and a brake cover 53 which is detachably attached to a front end part of the housing 51.

[0037]

The input shaft 35 is rotatably supported by the brake cover 52 and the housing 51, through front and rear bearings 58 which are mounted inside a brake chamber 55. The small bevel gear 37 projects inside a speed reduction gear chamber 56, and its rear end part is supported by a boss part 51a formed in the housing 51, through a bearing 59. That is, the small bevel gear 37 is supported thereby at locations of the front and rear end parts thereof.

[0038]

The large bevel gear 38 is positioned on the right side of the small bevel gear 37, and it is fixed (or screwed) to an outer surface of the hollow shaft 61 which extends in the direction of the right and left of the vehicle. The large bevel

gear 38 and the hollow shaft 61 are rotatably supported by the housing 51 and the right side cover 52 through bearings 62 which are arranged on the right and left sides of the large bevel gear 38. The hollow shaft 61 has an inner spline which engages with left and right output shafts 31 for the rear wheels 2. Each of the output shafts 31 projects from the housing 51 and the right side cover 52, in the direction of the right and left, respectively. Each of the outputs shafts 31 and 31 is connected to each of the drive shafts 33 and 33 for the rear wheels 2, through each of the constant velocity universal joints 32 and 32.

[0039]

As aforementioned, the input shaft 35 of the final reduction gear 30, tilts rightwards forwards at the angle of $\theta 1$ ($\theta=11^\circ$) with respect to the centerline C. In compliance with this construction, the front and rear side surface walls of the braking device 50 are so formed that the angle of $\theta 1$ ($\theta=11^\circ$) forms between each of the front and rear side surface walls thereof and a plane (or surface) M perpendicular to the centerline C, in the same direction as that of the input shaft 35.

[0040]

The wet multiple-disk braking device 50 has a plurality of friction plates 64 which engage with an outer

spline of the input shaft 35 so as to be able to move in the direction of the axis of the input shaft 35, a plurality of separators 66, which are mounted alternately with respect to the friction plates 64 in the direction of the axis, in which the separate plates 66 engage with an inner groove part 65 formed on an inner wall of the brake cover 53, movably in the direction of the axis, an annular pressure plate 67 which is mounted between the separate plate 66 at the front and a rear surface of the brake cover 53, a steel ball 68 of a cam mechanism for a braking operation, and so on. The pressure plate 67 is rotatably supported by a boss part formed inside the brake cover 53. The pressure plate 67 has a plurality of wedge grooves which are formed circumferentially at equal interval on its front edge surface. Each of the wedge grooves 69 is formed so as to extend in a shape of an arc in the direction of circumference of the pressure plate, and is formed so that a depth becomes shallows in one direction of the circumference. The steel balls 68 which are mounted inside concave parts 70 formed on the rear surface of the brake cover 53, engage with the wedge grooves 69, respectively, forming the cam mechanism for braking operation.

[0041]

The pressure plate 67 has a projection 67a on its outer surface, and the projection 67a engages with a brake operation lever 71 which is fixed to a lever shaft 72. The lever

shaft 72 is rotatably supported by the brake cover 53 and the housing 51, and the lever shaft 72 projects forwards from the brake cover 53. The lever shaft 72 is interlocked with an unshown brake operation part, such as a brake operation pedal, a brake operation lever, and so on, via an operational force transmission mechanism, such as a wire transmission mechanism.

[0042]

Namely, when the brake operation part is operated, and when the lever shaft 72 and the brake operation lever 71 are rotated, the pressure plate 67 is rotated, from a state shown in Fig. 3, with the projection 67a. Then, the pressure plate 67 moves backwards on the basis of the cam action between the steel ball 68 and the wedge groove 69. At this time, all of the friction plates 64 and all of the separate plates 66, are pinched, under a pressure, between the pressure plate 67 and the front surface wall of the housing 51, so that the input shaft 35 is braked thereby.

[0043]

(Cooling of Brake and Lubricant Device)

As a device for cooling the wet multiple-disk braking device 50, a lubricant circulation system in which the lubricant housed in the final reduction gear chamber 56 and in the brake chamber 55 is circulated, is employed. Furthermore, in order to promote the heat radiation from the lubricant at a high

temperature, the power transmission mechanism adopts a construction, by which a wind gained while the vehicle is running, and an air discharged from the automatic V-belt transmission, are used positively.

[0044]

Fig. 4 is a longitudinal side cross section (taken on a line of IV-IV of Fig. 3) of the final reduction gear 30 and the wet multiple-disk braking device 50. As shown in the figure, each of the friction plates 64 and separate plates 66, has an outer diameter which is smaller than the outer diameter of the large bevel gear 38. The brake cover 53 and the housing 51, have concave parts 77 and 78, at the bottom part, which extend in the direction of the width of the body of the vehicle. The concave parts 77 and 78 form an oil sump 79 having a large volume, for the lubricant, in a bottom part of the brake chamber 55. The oil sump 79 fluidically communicates with (or is connected to) a lower part of the final reduction gear chamber 56, via a lower oil passage 76.

[0045]

On the other hand, the housing 51 has a rear part which is formed as a circular arc so as to surround an outer circumference of the large bevel gear 38 with a small gap therebetween, to ensure a high ground clearance. Also, an upper inside of a front part of the housing 51, has an oil passage

80 which fluidically communicates with an upper inside of the final reduction gear chamber 56 and the upper inner circumferential groove part 65 of the brake chamber 55.

[0046]

Also, there is provided an oil passage 81 which forms between a front surface of the pressure plate 67 and the rear surface of the front edge brake cover 53, in which the oil passage 81 communicates with the inner circumferential groove part 65 and with a space inside the plurality of separate plates 66. A radially inwardly circumferential part of each of the friction plates 64, has a plurality of oil passage openings 83.

[0047]

Fig. 5 is a cross sectional view taken on a line corresponding with V-V in Fig. 4. In the figure, the oil passage openings 83 are formed on the friction plate 64 in the direction of circumference at equal interval, and the oil sump 79 is formed larger in the direction of the width of the vehicle, in which the oil sump 79 is secured to have a large volume for storing the lubricant.

[0048]

(Brake Cooling Mechanism Making Use of Air Discharged from Automatic V-belt Transmission)

In Fig. 2, the air outlet hole 17 provided at the rear end of the belt cover 13, is connected to an air discharging

guide 85. The air discharging guide 85 extends rearwards so as to ascend once, enters a space between the frames F, descends, and extends up to a vicinity of the front portion of the brake cover 53 of the wet multiple-disk braking device 50 as shown in Fig. 3.

[0049]

In Fig. 3, a rear part of the air discharging guide 85 extends diagonally leftward towards the rear of the vehicle, and a rear end part thereof is orientated and opened towards the brake cover 53. The rear end part of the air discharging guide 85 has a choke part 86 in order to increase the air discharging flow rate. Furthermore, there is provided a mixer tube 87 around the choke part 86, with a gap, or space, being formed radially circumferentially therebetween. The mixer tube 87 is in a shape of a taper. Namely, the construction thereof forms an air ejector. Thereby, the surrounding air is taken in, the amount of air (wind) is increased, and the temperature thereof is lowered.

[0050]

[Effect]

(Transmission of Drive Power for Moving Vehicle)

In Fig. 1, the drive power which is outputted from the crankshaft of the engine 10, is transmitted to the gear transmission 12 through the automatic V-belt transmission 11,

and then the drive power is transmitted to the power takeoff shaft 39 from the output shaft 43 through the bevel gears 42 and 43.

[0051]

The drive power is transmitted from the front part of the power takeoff shaft 39 to the front propeller shaft 26 for the front wheels through the spline coupling 28. On the other hand, the drive power is transmitted from the rear part of the power takeoff shaft 39 to the rear propeller shaft 36 for the rear wheels through a constant velocity universal coupling 40.

[0052]

The drive power which is transmitted to the front propeller shaft 26, is reduced in rotational speed inside the differential gear 20. The drive power is, then, transmitted to both of the constant velocity universal joints 22, to both of the front wheel drive shafts 23, to both of the constant velocity universal joints 24, and to both of the front wheels 1.

[0053]

In Fig. 3, the drive power which is transmitted to the rear propeller shaft 36 in a posture of inclination, is transmitted to the input shaft 35 of the final reduction gear 30, through the spline coupling. Then, the drive power is

changed in direction by the small bevel gear 37 and the large bevel gear 38, while the drive power is reduced in rotational speed, the drive power is transmitted to both of the right and left output shafts 31 through the hollow shaft 61, and then the drive power is transmitted to the right and left drive shafts 33 through the constant velocity universal couplings 32.

[0054]

(Cooling of Brake)

In Fig. 4, the lubricant contained in the oil sump 79 formed under the wet multiple-disk wet braking device 50, is forced to be flowed upwards in the direction shown by an arrow "R" on the basis of rotation of the large bevel gear 38. The lubricant is then moved into the inner circumferential groove part 65 locating in the front part of the final reduction gear 30, through the oil passage 80 locating in the upside of the final reduction gear chamber 56, thus cooling down the radially outer circumferential part of the separate plates 66. Subsequently, the lubricant passes through the oil passage 81 locating forward of the pressure plate 67, to cool down the pressure plates 67. At the same time, the lubricant enters the radially inner circumferential part of the separate plates 66. Then, the lubricant cools down the friction plates 64 while passing through the oil passage openings 83 thereof, and then the lubricant returns back to the oil sump 79.

[0055]

In this way, the lubricant circulates through the whole space of the final reduction gear chamber 56 and the brake chamber 55. Therefore, a large radiation area for releasing any heat generated in the final reduction gear 30 and the wet multiple-disk braking device 50, is surely secured, and the cooling of the braking device is enhanced thereby. Also, the oil sump 79 is positioned in the brake chamber 55 which locates in front of the final reduction gear 30. Therefore, the lubricant stored in the brake chamber 55, and the lubricant stored in the oil sump 79, are effectively cooled down by the air, or wind, blown from front while the vehicle is running.

[0056]

Furthermore, in Fig. 3, the air discharged from the belt cover 13 is discharged through the air discharging guide (or pipe) 85 increases in speed at the choke part 86 where outside air is taken in (or sucked) through the mixer tube 87, and the air at an increased velocity and airflow is hit on the front edge brake cover 53. Thereby, the heat radiation effect (or heat liberation effect) is promoted.

[0057]

Furthermore, the brake cover 53 tilts with respect to the surface (or plane) M which is perpendicular to the centerline C of the vehicle. Therefore, the air blown from

front of the vehicle during its running, flows smoothly along the front surface of the brake cover 53 from the left to the right thereof, so that the heat radiation effect is further enhanced.

[0058]

By the way, the air discharging guide 85 has a vertically ascending (or rising) part, as shown in Fig. 2, between the air outlet hole 17 of the belt cover 13 and the choke part 86. Therefore, water is effectively prevented from entering the belt cover 13 from the choke part 86.

[0059]

[Another Embodiment]

(1) The vehicle to which the present invention applies, is not limited to the all-terrain four-wheeled drive vehicle, and the present invention can apply to another type of four-wheeled drive vehicle or rear-wheeled drive vehicle.

[0060]

(2) The present invention can also apply to the four-wheeled vehicle which has a mechanism for switching between a two-wheel drive and a four-wheeled drive, in which the power takeoff shaft is divided into two in a direction of front and rear.

[0061]

[Effect of the Invention]

According to the present invention as explained above,

(1) the air discharging duct is connected to the air outlet hole of the belt cover which covers the automatic V-belt transmission, the air discharging duct extends up to the braking device or up to the vicinity thereof, and the air is discharged towards the braking device. Therefore, there is no need of providing a fan, etc. for cooling the braking device exclusively, and it is possible to promote the performance to cool down the same at a low cost.

[0062]

(2) The air discharging duct has the rising part which is higher than the outlet part of the air discharging duct, and it is possible to prevent water and/or mud from entering the belt cover through the air discharging duct. Therefore, the mechanism is advantageous to the all-terrain vehicle which runs on a seashore, a waste land, etc.

[0063]

(3) The brake device is the wet multiple-disk braking device. With the mechanism, the radius of the frictional plate of the brake device can be made small, and enough volume, for lubricant, of the oil sump below can be secured without lowering the bottom surface of the casing.

[0064]

(4) The wet multiple-disk braking device is mounted in front of the final reduction gear for the rear wheels, the wet multiple-disk braking device and the final reduction gear are housed inside the single (or common) casing, and the single casing has the oil sump under the wet multiple-disk braking device. Therefore, it is possible to store a large volume of lubricant therein and to secure enough height of the final reduction gear for the rear wheels relative to the ground level. Also, the lubricant circulates inside the single casing having the large volume. Therefore, a large heat radiation area (heat releasing area) is secured, the heat releasing effect increases, and the cooling-down effect enhances.

[0065]

Furthermore, the braking device is arranged in front of the final reduction gear for the rear wheels, and the oil sump is arranged in the casing part. Thereby, the wind (or air) from the fore is hit on the casing part of the braking device while it is running, and the function to radiate the heat is promoted.

[0066]

(5) The front surface of the casing of the braking device tilts with respect to the direction of the width of the vehicle. Thereby, the air hitting on the casing of the braking device from the front thereof while the vehicle is running, flows

readily and smoothly along the front surface of the casing, resulting in increase of effect to release (radiate) the heat.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1] It is a plan view showing a drive power transmission system for a four-wheeled drive vehicle, to which the present invention applies.

[Fig. 2] It is a right side view of the four-wheeled drive vehicle of Fig. 1.

[Fig. 3] It is an enlarged horizontal cross sectional view showing a final reduction gear for rear wheels and a wet multiple-disk braking device.

[Fig. 4] It is a cross sectional view taken on a line corresponding with IV-IV in Fig. 3.

[Fig. 5] It is a cross sectional view taken on a line corresponding with V-V in Fig. 4.

[Reference Symbols]

11	an automatic V-belt transmission
13	a belt cover
16	an air inlet hole for cooling
17	an air outlet hole for discharging air
30	a final reduction gear for rear wheels
35	an input shaft for the final reduction gear for rear wheels
36	a rear propeller shaft for rear wheels

37	a bevel gear for the final reduction gear for rear wheels
38	a bevel gear for the final reduction gear for rear wheels
39	a power takeoff shaft
50	a wet multiple-disk braking device
51	a housing
52	a right side cover
53	a front edge brake cover (common casing)
79	an oil sump
80	an oil passage
81	an oil passage
83	an oil passage opening

Document Name: Drawings

Fig. 1

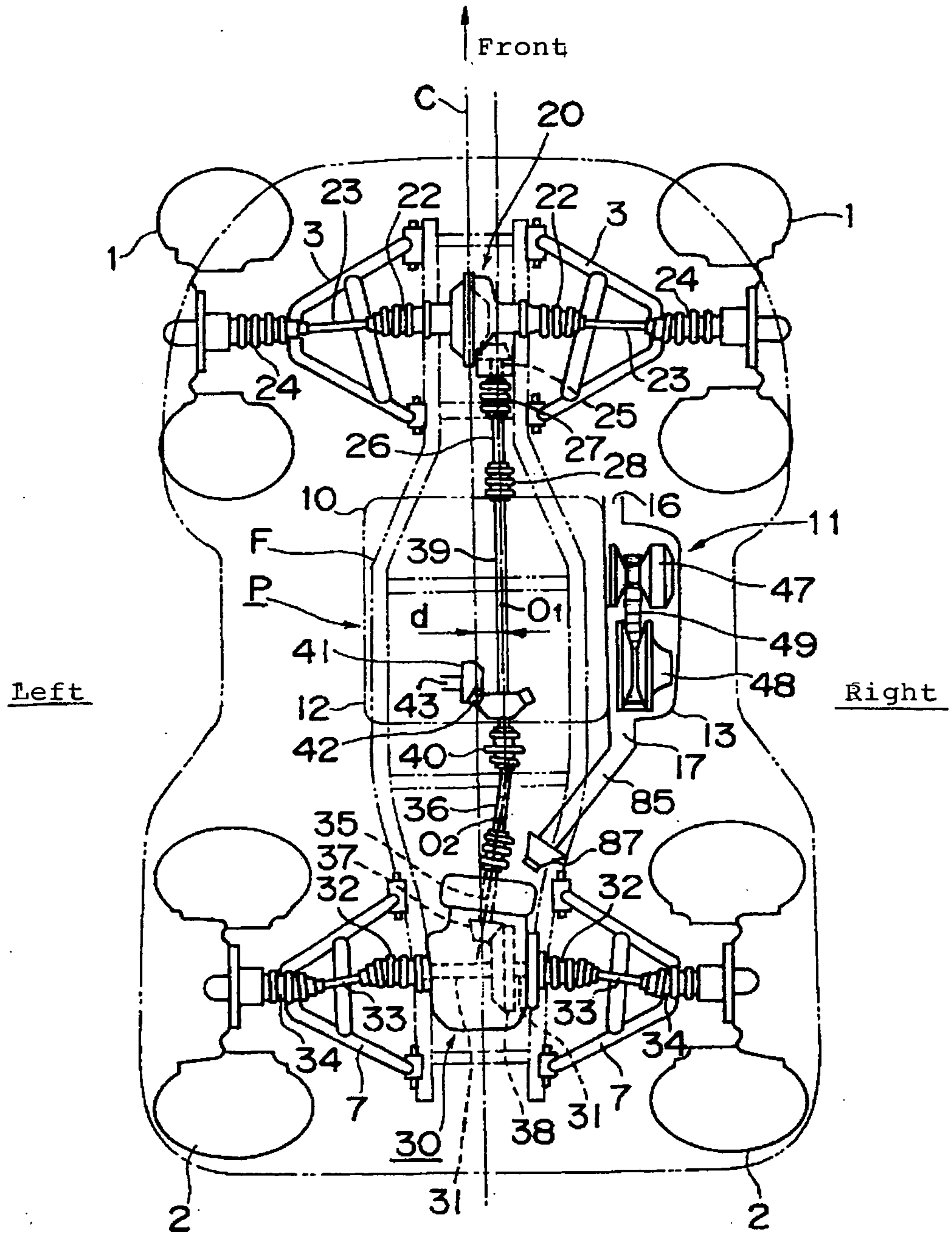
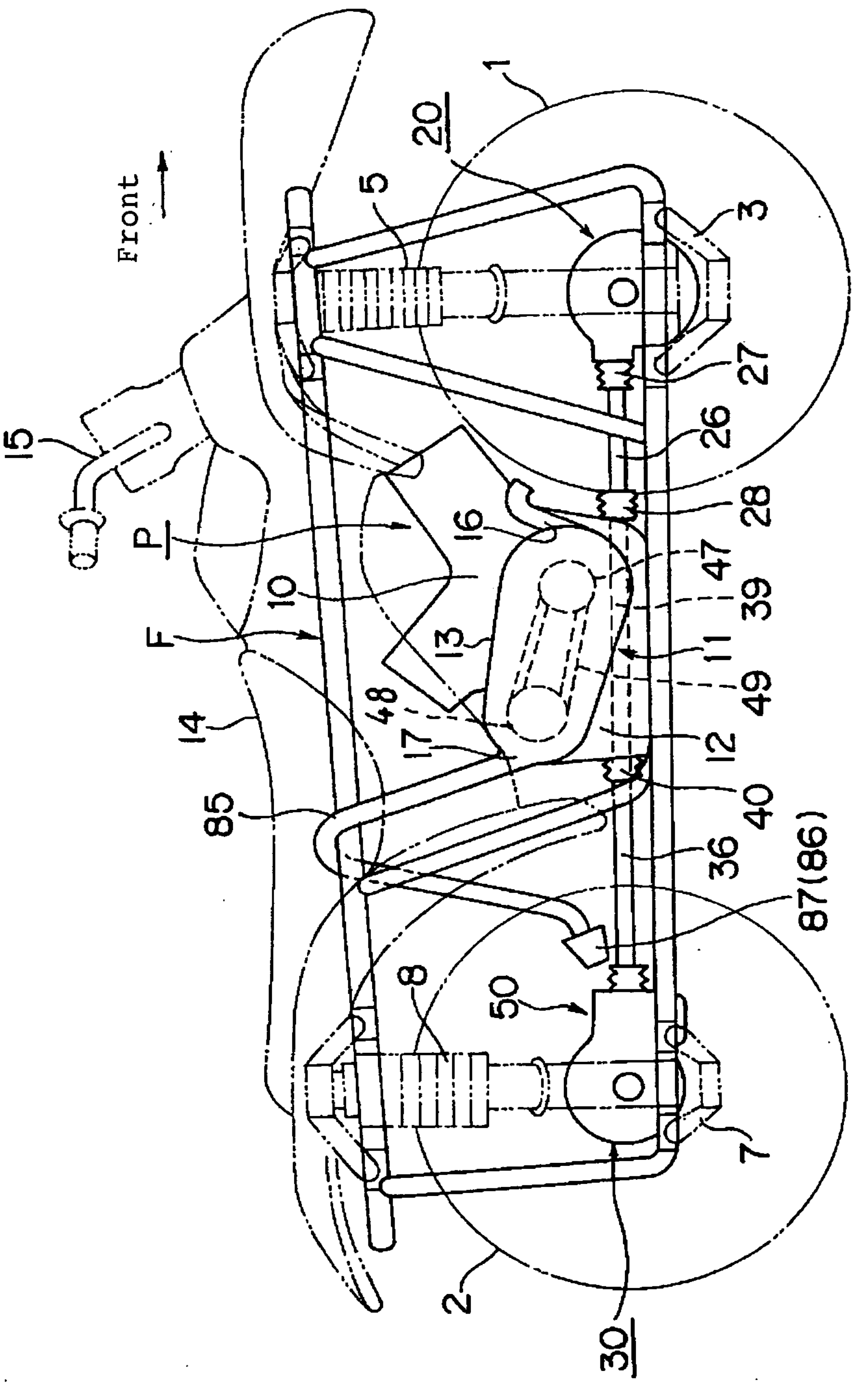


Fig. 2



Front
1
20
5
3
27
26
28
15
P
16
47
39
10
F
13
11
49
48
17
12
14
40
85
36
87(86)
8
50
7
2
30

Fig. 3

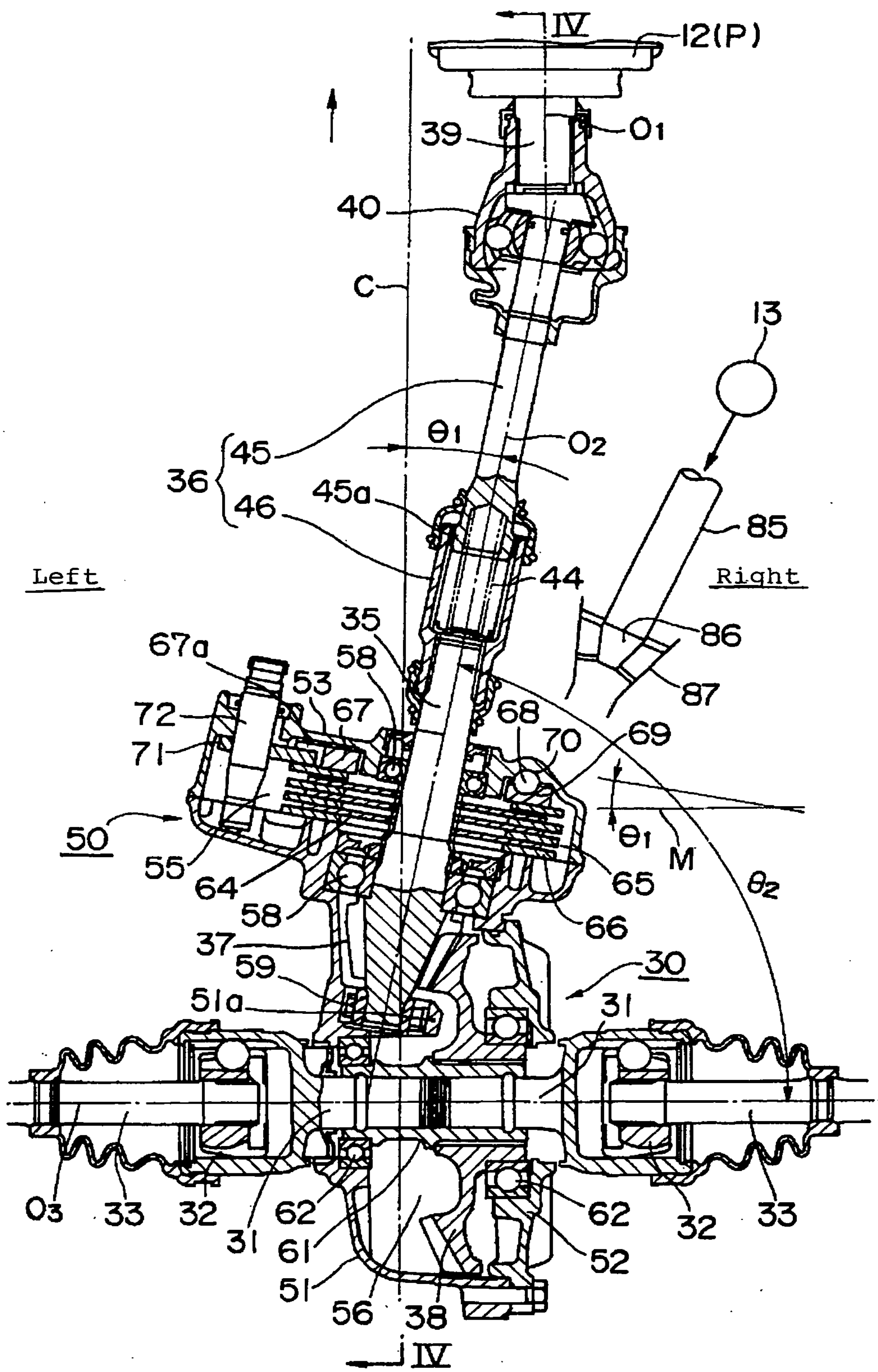
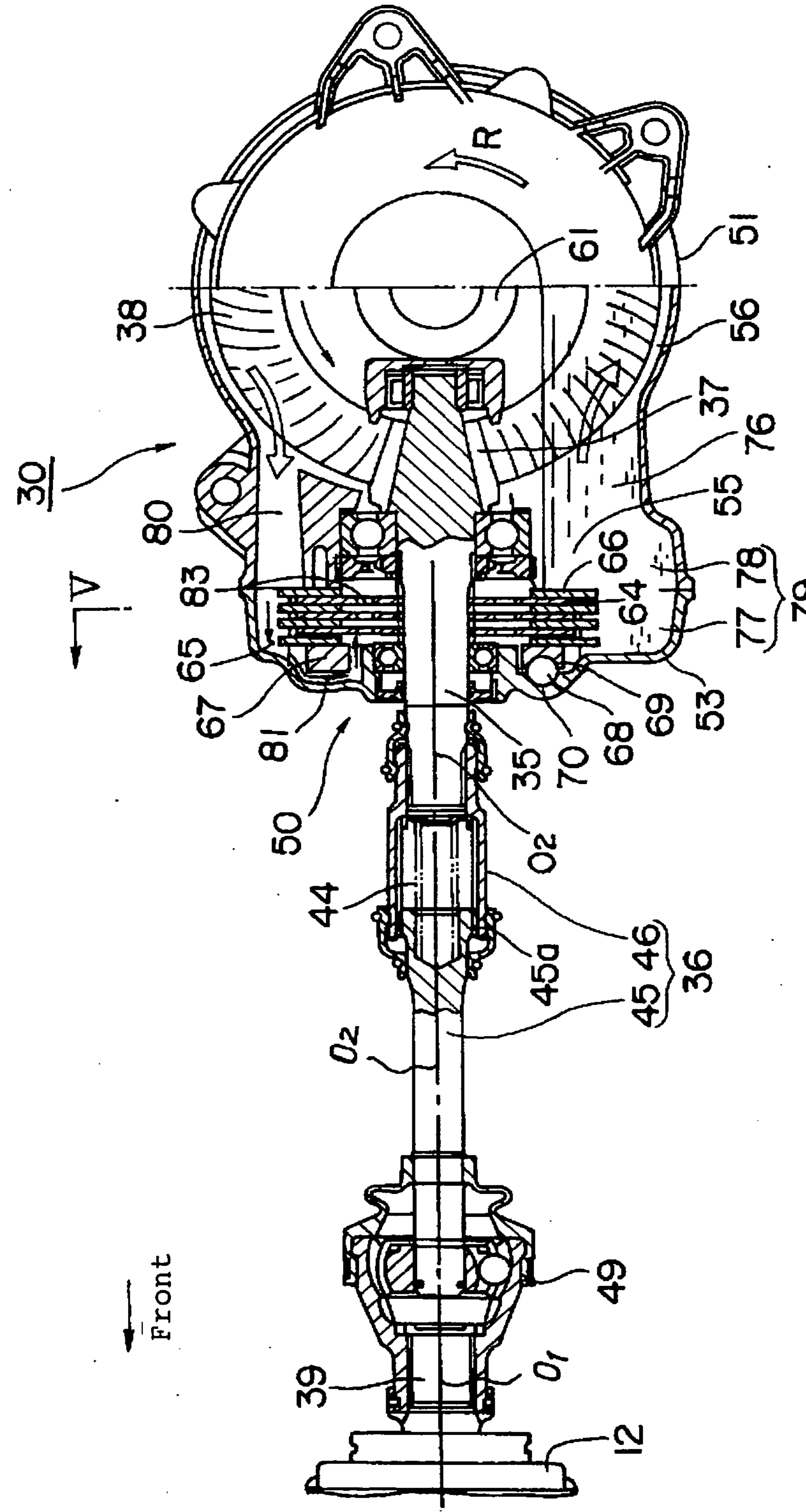
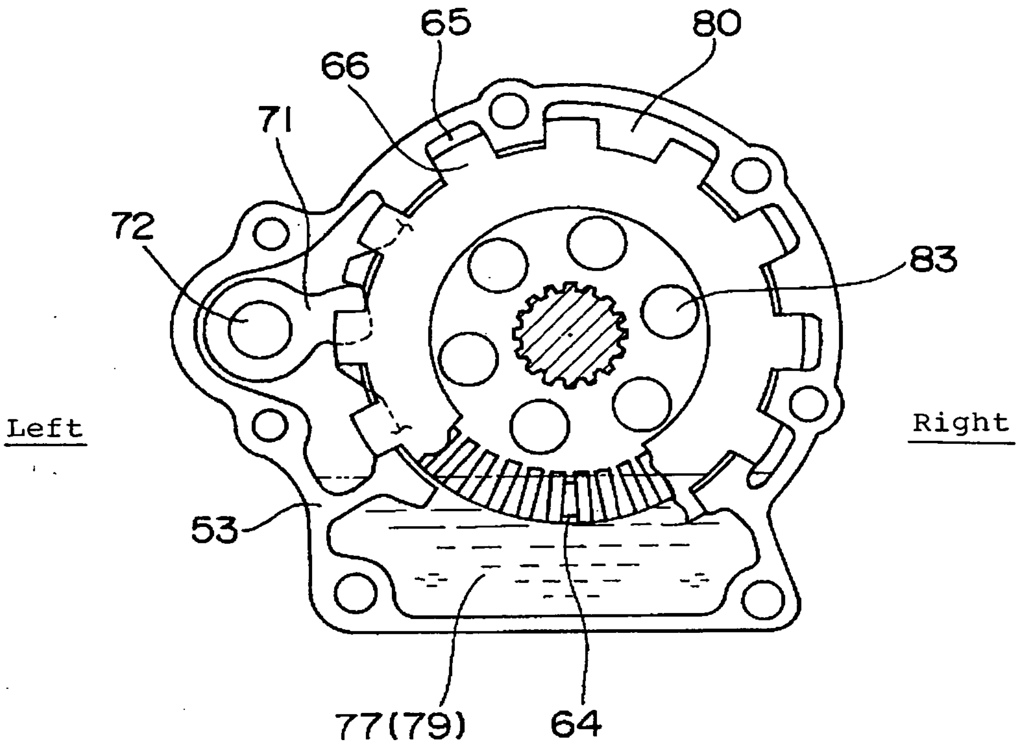

IV
12(P)
O1
39
40
C
13
45
θ1
O2
36
45a
46
85
Left
Right
44
35
86
67a
58
53
87
72
67
68
70
69
71
50
55
64
θ1
M
65
θ2
58
66
37
30
59
31
51a
O3
33
32
31
62
61
62
52
32
33
51
56
38
IV

Fig. 4



R
61
51
38
56
37
76
30
55
80
66
83
V
64
78
79
77
V
65
67
81
35
70
68
69
53
50
O2
44
46
45a
36
45
O2
Front
49
39
O1
12

Fig. 5



[DOCUMENT NAME] Abstract of the Disclosure

[ABSTRACT]

[Object] The object is to radiate frictional heat generated in the braking device from a casing surface efficiently. Also, the object is to secure enough minimum height of a vehicle body relative to the ground, with improvement of the function to radiate the heat.

[Constitution] A brake cooling device for four-wheeled drive vehicle, in which a rotational member of a power transmission system for rear wheels, such as an input shaft 35 of a final reduction gear 30 for rear wheels, is provided with a braking device 50. An air discharging duct 85 is connected to an air outlet hole 17 of a belt cover 13 which covers an automatic V-belt transmission 11. The air discharging duct 85 extends up to the braking device 50, or up to a vicinity thereof, and the air is discharged towards the braking device 50. The braking device 50 is arranged in front of the final reduction gear 30 for rear wheels, and both 30, 50 thereof are accommodated inside a common casing. More preferably, the braking device 50 has a front surface which is formed so as to tilt with respect to a width of the vehicle.

[Selected Drawing] Fig. 1

Applicant Record

Identification No.: 000000974

1. Date of Registration: August 22, 1990 (newly recorded)

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